# UNIT 5
# COMPUTER ARITHMETIC

# Unsigned & Signed (Magnitude, 1's & 2's Complement) Numbers

| Decimal | Unsigned | Signed | | |
|---|---|---|---|---|
| | | Signed Magnitude | Signed 1's Complemet | Signed 2's Complemet |
| 40 | 101000 | 0101000 | 0101000 | 0101000 |
| -40 | - | 1101000 | 1010111 | 1011000 |
| 8 | 1000 | 01000 | 01000 | 01000 |
| -8 | - | 11000 | 10111 | 11000 |
| 14 | 1110 | 01110 | 01110 | 01110 |
| -14 | - | 11110 | 10001 | 10010 |
| 13 | 1101 | 01101 | 01101 | 01101 |
| -13 | - | 11101 | 10010 | 10011 |

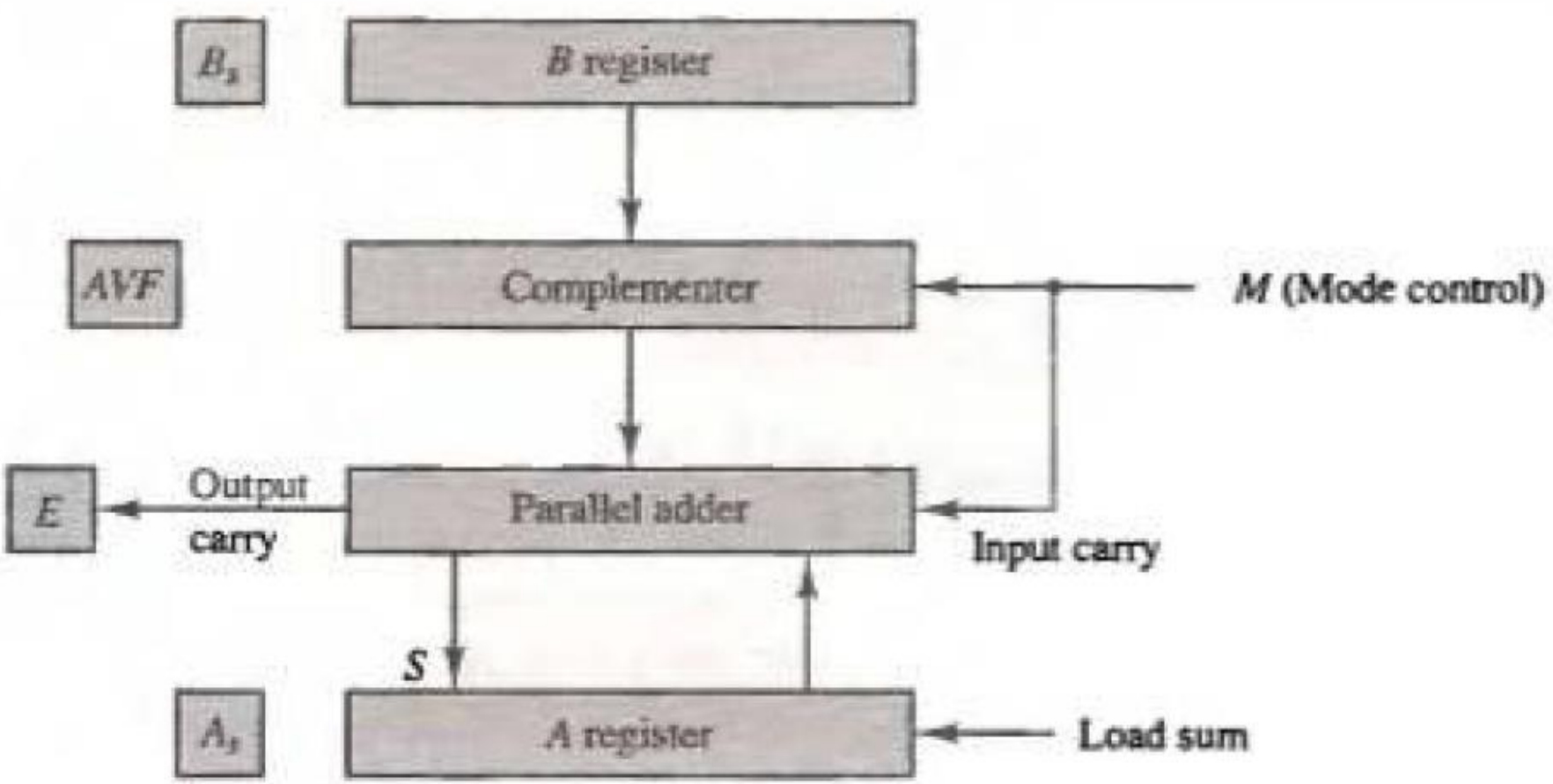
| Binary | Unsigned | Signed | | |
|---|---|---|---|---|
| | | Signed Magnitude | Signed 1's Complemet | Signed 2's Complemet |
| 10110 | 22 | -6 | -9 | -10 |
| 10010 | 18 | -2 | -13 | -14 |
| 10001 | 17 | -1 | -14 | -15 |
| 10011 | 19 | -3 | -12 | -13 |
| 1011000 | 88 | -24 | -39 | -40 |
| 1010111 | 87 | -23 | -40 | -41 |

# Addition & Subtraction of Signed-Magnitude Numbers

**TABLE 10-1** Addition and Subtraction of Signed-Magnitude Numbers

| Operation | Add Magnitudes | Subtract Magnitudes | | |
|---|---|---|---|---|
| | | When $A > B$ | When $A < B$ | When $A = B$ |
| $(+A) + (+B)$ | $+(A + B)$ | | | |
| $(+A) + (-B)$ | | $+(A - B)$ | $-(B - A)$ | $+(A - B)$ |
| $(-A) + (+B)$ | | $-(A - B)$ | $+(B - A)$ | $+(A - B)$ |
| $(-A) + (-B)$ | $-(A + B)$ | | | |
| $(+A) - (+B)$ | | $+(A - B)$ | $-(B - A)$ | $+(A - B)$ |
| $(+A) - (-B)$ | $+(A + B)$ | | | |
| $(-A) - (+B)$ | $-(A + B)$ | | | |
| $(-A) - (-B)$ | | $-(A - B)$ | $+(B - A)$ | $+(A - B)$ |

# Hardware Implementation



# Flowchart for Add & Subtract Operation

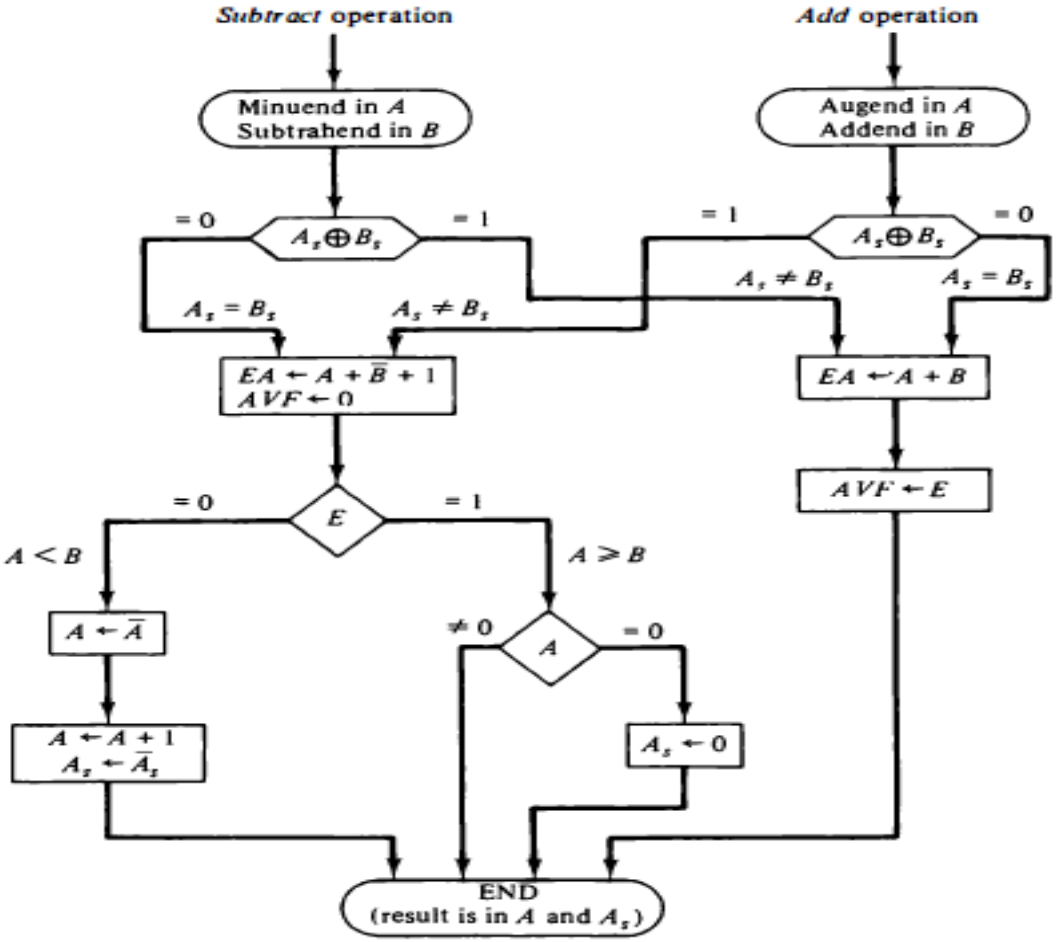
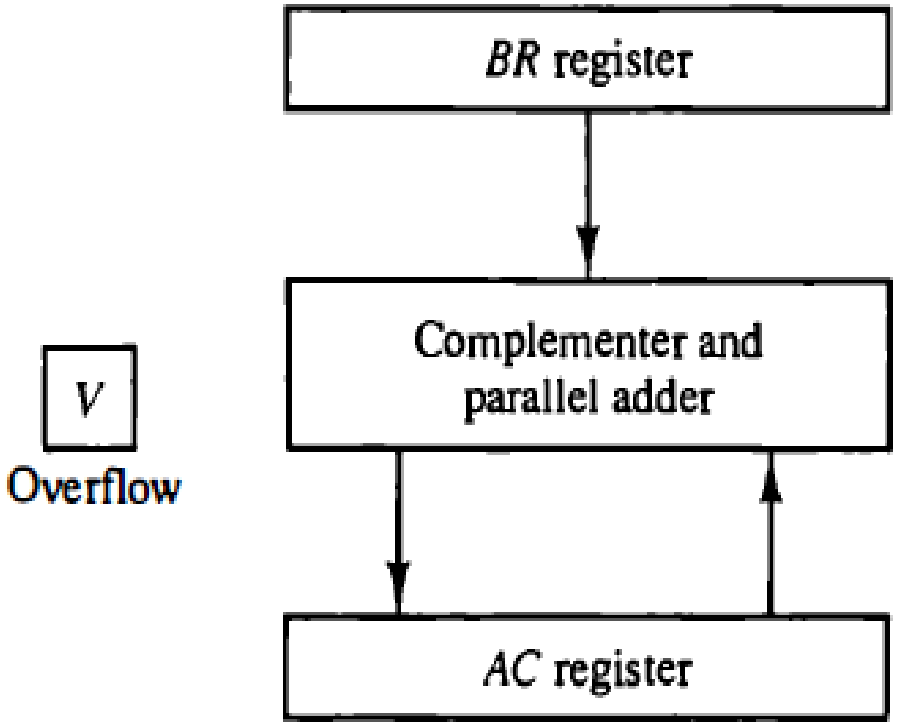



**Figure 10-2** Flowchart for add and subtract operations.

# Addition & Subtraction of Signed-2'S Complement Numbers

**Figure 10-3** Hardware for signed-2's complement addition and subtraction.



# Addition & Subtraction of Signed-2'S Complement Numbers

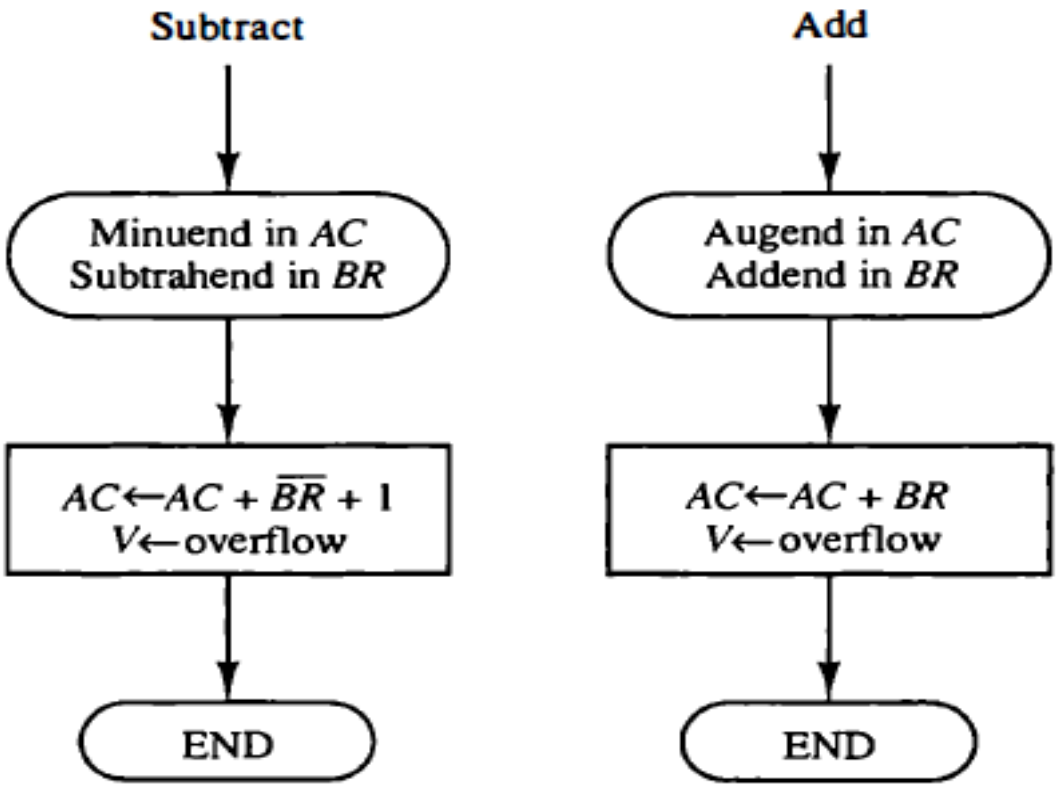
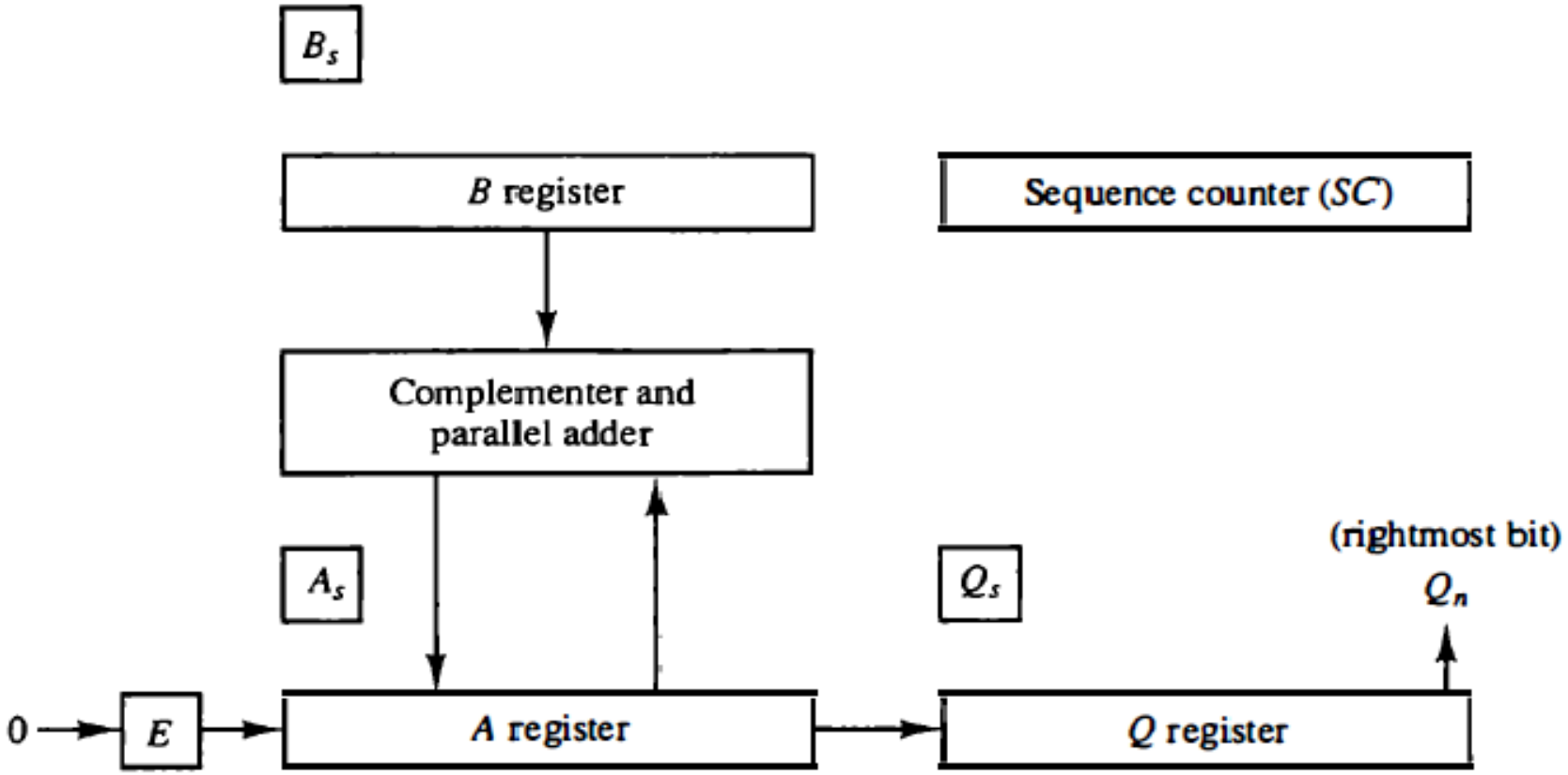



**Figure 10-4** Algorithm for adding and subtracting numbers in signed-2's complement representation.

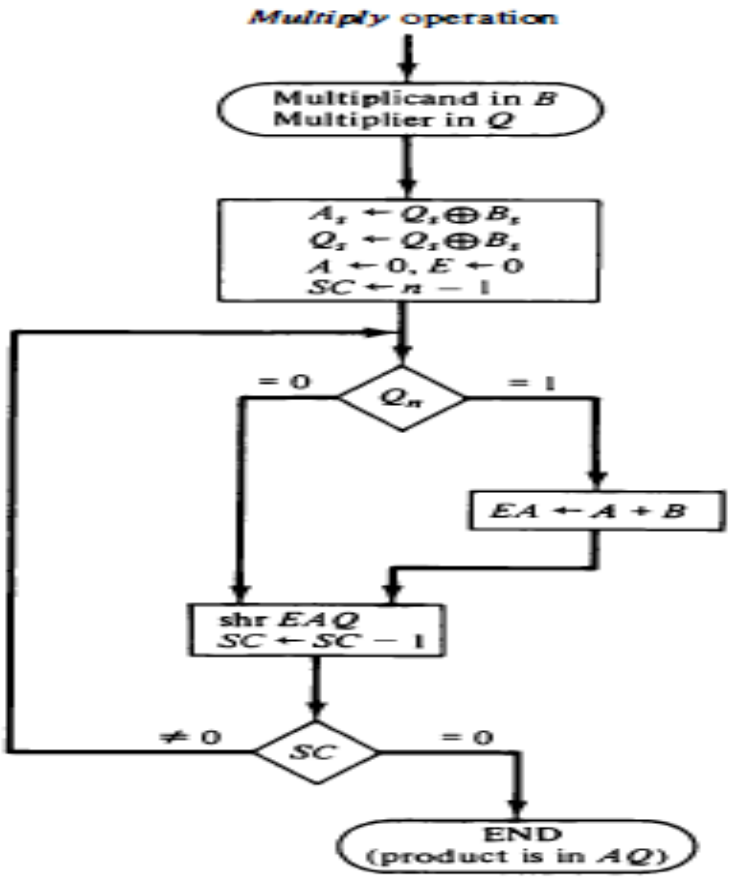
# Multiplication Algorithms

**Figure 10-5** Hardware for multiply operation.



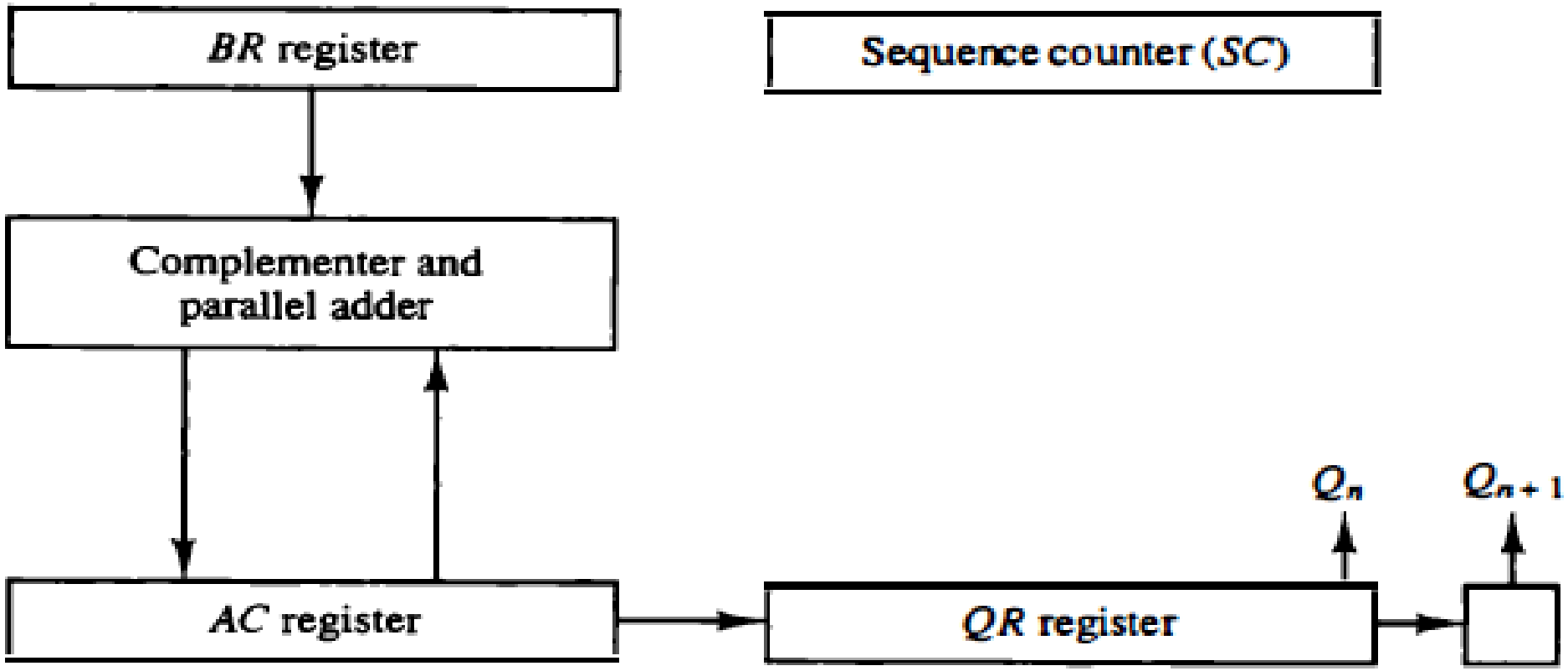
# Multiplication Algorithms

**Figure 10-6** Flowchart for multiply operation.

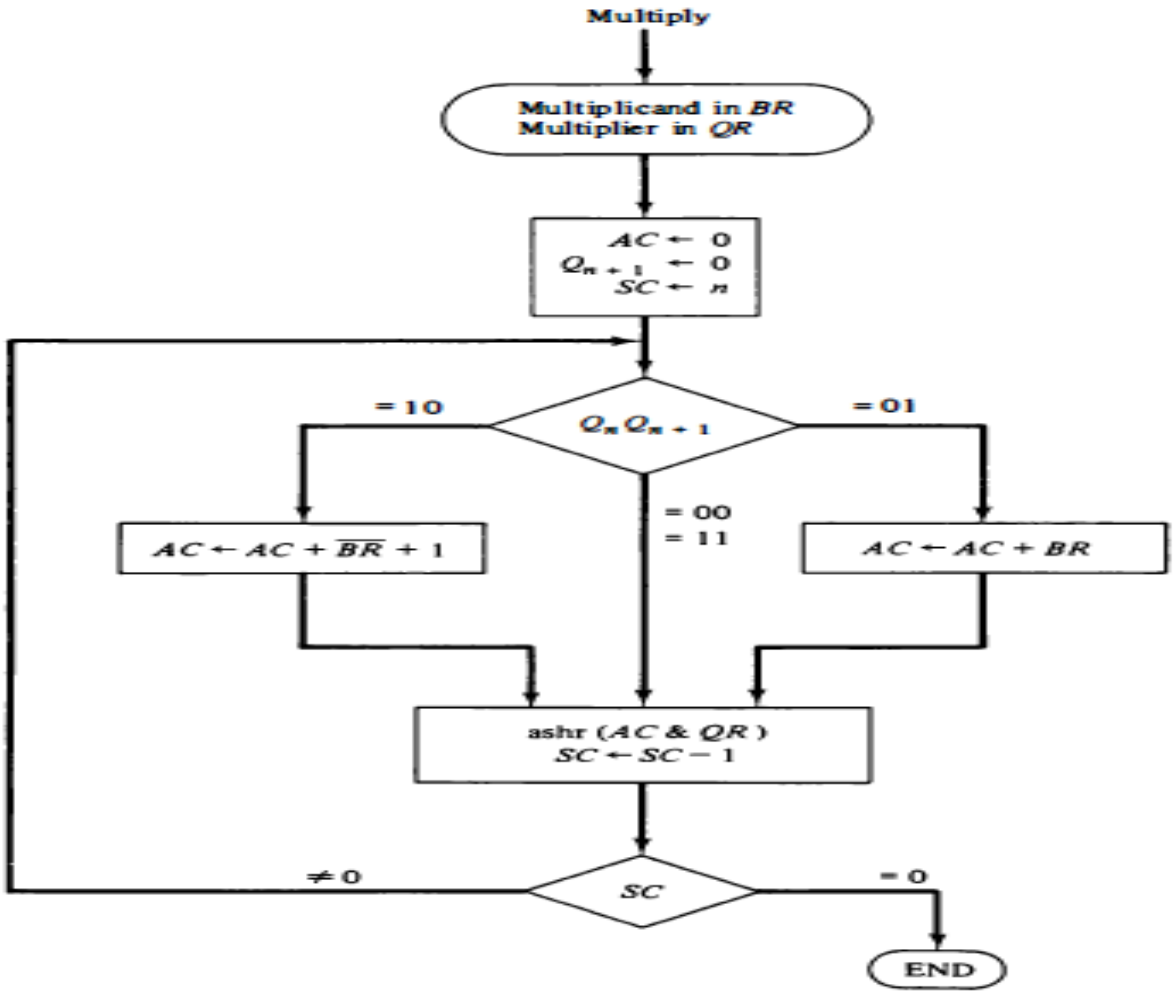


# Hardware for Booth Algorithm

**Figure 10-7 Hardware for Booth algorithm.**

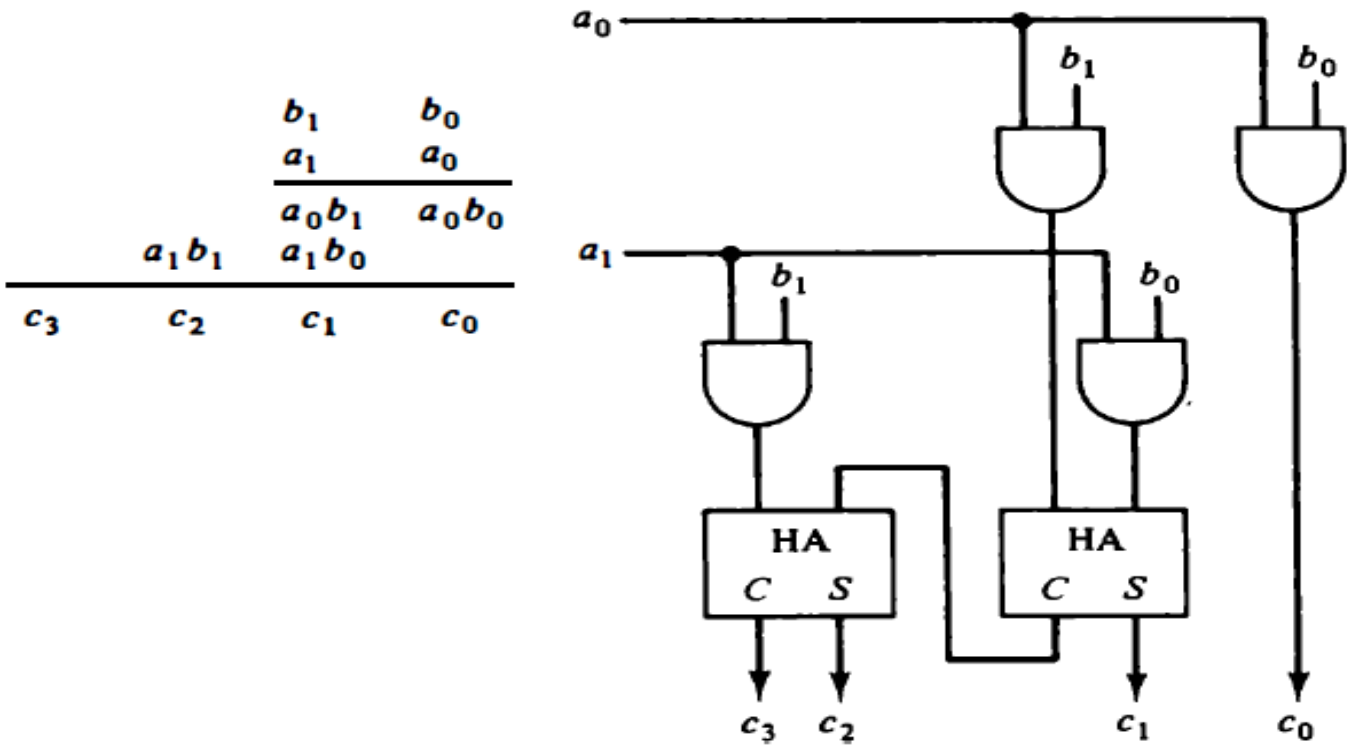


# Booth Algorithm for Multiplication

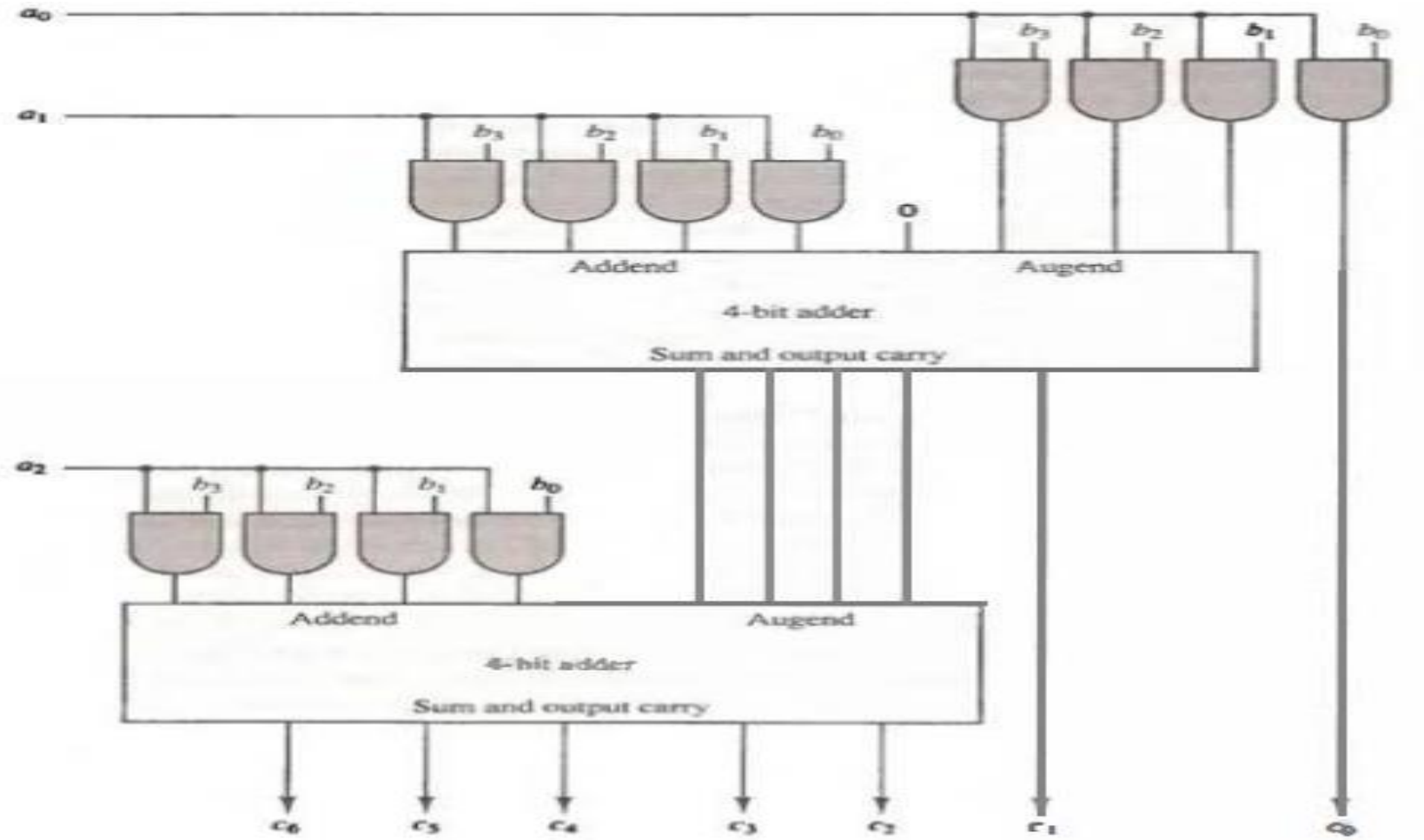


# Array Multiplier

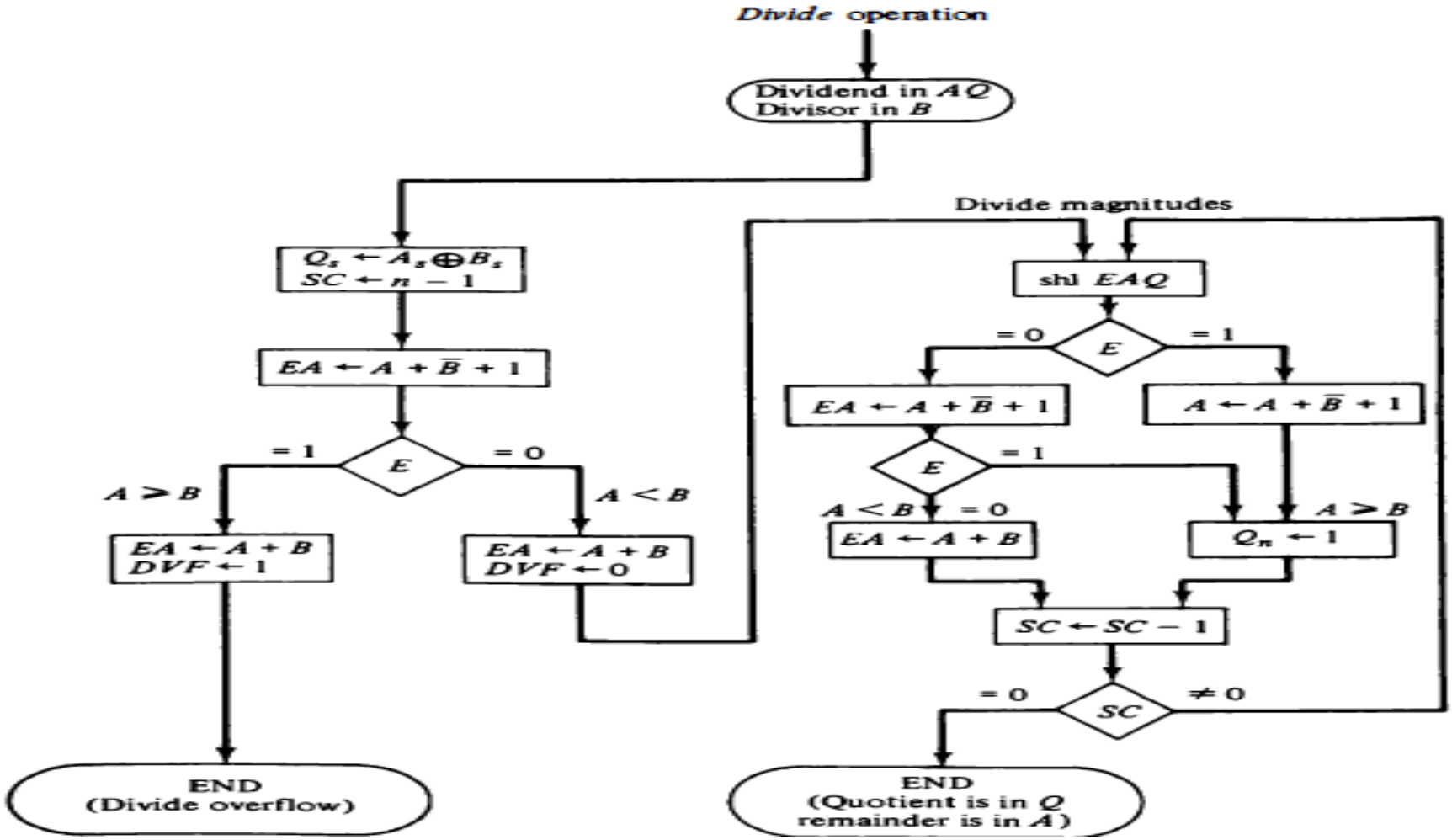
**Figure 10-9** 2-bit by 2-bit array multiplier.



# Array Multiplier



# Division Algorithm



# Floating Point Arithmetic

**Addition & Subtraction**

- Check for zeros
- Align the mantissas
- Add or Subtract the mantissas
- Normalize the result

# Floating Point Arithmetic

**Multiplication**

- Check for zeros
- Add the exponents
- Multiply the mantissas
- Normalize the result

# Floating Point Arithmetic

**Division**

- Check for zeros
- Initialize the registers and evaluate the sign
- Align the dividend
- Subtract the exponents
- Divide the mantissas